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Cover Page Footnote

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Evaluation of the Michigan Water School: Water Education Program for Local Leaders

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Abstract. Local leaders are essential for helping Michigan achieve its 30-year water strategy goals. The Michigan Water School is an Extension nonformal educational program to address the knowledge gap of local leaders. We evaluated programs conducted from 2017 to 2019. Results revealed program outcomes in knowledge, attitudes, perceptions of criticalness to work, and stewardship and behavioral intentions aligned to water quality, water quantity, and field experience units. Growth areas for program improvement include water policy, economics, planning, and finance as well as expanding the focus of the program for transformational leadership and to broaden recruitment efforts.

INTRODUCTION

Sustainable water resource systems must take into account economic development needs while reducing their impacts to ecosystem function and social welfare over time (Loucks, 2000). Local leaders are integral to the development and implementation of these systems. In the United States, decisions pertaining to land-use zoning, storm water management, water use ordinances, waste and drinking water infrastructure, and greenspaces usually occur at the local level (Dale et al., 2000). Making these decisions can be challenging if local and regional water resource issues are met with tension among stakeholders and conflicting expectations of the resource. This can be especially true when the water resource spans multiple political jurisdictions or watersheds (Grigg, 2015). Changing weather and climate patterns, technology, and evolving policy and socioeconomic trends are likely to make managing water resources even more challenging (Burbach & Reimers-Hild, 2019).

Water literacy in the Laurentian Great Lakes is an important component of achieving Michigan's 30-year Water Strategy for protecting, managing, and enhancing the state's water resources (EGLE, 2016). A solid foundation in water science and management—coupled with leadership skills and knowledge of tribal cultural values—may help advance water resource collaboration for the common good by addressing complex issues that involve uncertainty and differing viewpoints, values, and intentions known as "wicked problems" (Rittel & Webber, 1973; Burbach et al., 2019; RESPECT Act, 2019). Efforts to develop processes and policies that center partnership with tribes and further efforts to develop collaboration and consensus-building will likely result in outcomes that are more acceptable to a broader base of stakeholders (Jacobson & Decker, 2008; Decker et al., 2015; RESPECT Act, 2019).

Further challenges may lie in obtaining and interpreting the scientific information required to make informed decisions. Local leaders may be:

- elected officials (e.g., city, village, or township trustees),
- appointed officials (e.g., planning commission or zoning board members),
- municipal staff (e.g., engineer or wastewater treatment staff),
- non-governmental staff (e.g., planners with a watershed council),
- resource managers (e.g., local staff from a state natural resource or environmental agency), or
- interested members of the public.

Locally elected or appointed officials are not required to have scientific training or experience. Additionally, high turnover among municipal staff negatively impacts specific knowledge of local networks and contexts (Center for

State and Local Government Excellence, 2016). One way to enhance the capacity of local leaders' ability to make water resource management decisions is through nonformal education programs that are planned by institutions or organizations and that occur outside of schools (e.g., formal education) or specific situations (e.g., informal education at a nature center) (Maarschalk, 1988; Wolfson et al., 2015). Over the years, both Cooperative Extension and Sea Grant Extension programs have developed, implemented, and evaluated a variety of nonformal water-related educational programs for adult learners and community leaders (Burbach & Reimers-Hild, 2019; Wolfson et al., 2015; Michigan State University Extension, 2019).

In Michigan, there was an opportunity to develop and deliver a water resource Extension program to educate local leaders. Due to our connections with local, state, and tribal governments; non-governmental organizations; experts; and others, Michigan State University Extension and Michigan Sea Grant were in a unique position to assess local needs and develop and implement Extension programs that improved local leaders' water literacy. Modeled after the Florida Water School (University of Florida IFAS, 2022), Michigan's Water School (hereafter Water School) is a policy-neutral program that provides local leaders with critical, relevant information needed to understand their community water resources. Water School aims to equip local leaders with the necessary scientific background and practical knowledge about policy, economics, and planning that can help them fulfill their role of balancing use and protection of water resources. Beyond making specific water policy decisions, local leaders may also oversee local water districts or environmental agencies that are important sources of information to residents of their communities (Gholson et al., 2018).

Michigan's Water School was designed as a two-day, in-person program consisting of five classroom-based units and a field experience opportunity (Table 1). Coordinators presented information via both in-class presentations and interactive learning demonstrations. Local partners, such as watershed organizations, typically provided unit instruction to address location-specific issues and to provide field experience, customizing each program for the watershed region in which they were held. The water quality and water quantity units provided an overview of water science, while the policy and planning units provided practical knowledge for the management of water resources and the application of the new information.

The primary target audience for this program were local leaders in Michigan. Local watershed organizations were essential in identifying points of contact and recruiting participants. We implemented the pilot program in May 2017 in Oakland County, Michigan, in partnership with Lawrence Technological University. We then offered four additional programs in Michigan; these included one in 2018 in Grand Traverse County (in partnership with Leelanau County Planning and Economic Development, Rotary Charities of Traverse City, and the Watershed Center Grand Traverse Bay) and three in 2019: one in Oakland County (in partnership with the Clinton River Watershed Council), another in Washtenaw County (in partnership with the Huron River Watershed Council), and one in Oakland/Wayne Counties (in partnership with Friends of the Rouge) (Table 2). We required individuals to pre-register and commit to attending both days of the program. Ninety-six individuals (i.e., local leaders)—representing municipal staff, elected or appointed local officials, watershed advocacy groups, resource managers, the public, or other interested persons—registered for the Water School programs (Table 2). Limited participant support fees (e.g., scholarships) were available to offset the $175 registration fee (though there was no registration fee for the pilot program).

The goal of this evaluation was to assess the short-term outcomes of the Water School program on participants' water literacy, specifically perceptions of knowledge and skills critical to work, knowledge, attitudes, behavioral intentions, and perceptions of stewardship capabilities.

METHODS

To understand the effectiveness and short-term outcomes of the Water School, we invited participants to complete pre- and immediate post-program surveys for our post- vs pre-program evaluation design (Patton, 2002). We implemented this immediate pre- and post-program survey to reduce other possible sources for the changes we sought to measure (Shadish et al., 2002). We did not conduct a non-response error survey; we did not examine response shift bias from the pre-and post-survey evaluation design.

Pre- and post-survey questions addressed participants' perceptions of how critical water knowledge is to their work using 14 statements with 5-point Likert-type response options ranging from 1 (*not critical at all*) to 5 (*very critical*) based upon Wolfson et al. (2015). We analyzed pre- and post-survey statement responses for significance using Wilcoxon signed-ranks tests. We assessed knowledge of water and water management with four multiple choice and 12 true/false questions modified from Dann & Schroeder (2015). We compared percent of correct responses, percent of incorrect responses, and percent of unsure responses on both pre- and post-surveys. The attitudes toward water quality and management pre- and post-survey questions included seven statements with 5-point Likert-type response options from 1 (*strongly disagree*) to 5 (*strongly agree*), adapted from Busse et al. (2015). The statements asked respondents' opinions of water management actions related to economic development, community stability, and quality of life. We measured perceptions of stewardship and behavioral intentions using

Table 1. Michigan Water School Curriculum for Local Leaders, 2017–2019

Unit	Major topics
Local issues	Local water impairments and ongoing projects Resources and success stories
Water quantity	Groundwater and hydrology basics State and local drinking water sources Groundwater protection
Water quality	Historical perspective of water pollution nationally and locally Point, non-point, and biological pollution Overview of current and emerging issues impacting water resources
Water economics, planning, and finance	Water's importance to local and regional economies Strategies to incorporate water into local planning Benefits to water conservation and regulation Water contamination risk management
Water policy	Overview of water law and policy (local, state, tribal, federal) in the Great Lakes Government roles and responsibilities regarding water policy Water policy toolbox and other resources
Field experience	Hands-on watershed-specific experiential learning to reinforce unit topics Interactions with water resource professionals

Table 2. Michigan Water School Program Locations, Registrants, and Pre- and Post-Survey Response Rates, 2017–2019

Water School Session (year)	No. Registered	No. Pre-Survey Responses	Response Rate (%)	No. Post-Survey Responses	Response Rate (%)
Oakland County (2017)	16	15	94%	9	56%
Grand Traverse County (2018)	28	19	68%	6	21%
Oakland County (2019)	23	11	48%	7	30%
Washtenaw County (2019)	15	8	53%	2	13%
Oakland/Wayne County (2019)	14	6	43%	3	21%
Overall	**96**	**59**	**61%**	**27**	**28%**

Note. All who registered for the program were accepted as participants.

11 statements with 5-point Likert-type response options ranging from 1 (*strongly disagree*) to 5 (*strongly agree*), based upon Dann & Schroeder (2015).

We followed established guidelines for questionnaire and layout; we modified the approach by using email to invite participants to complete an online survey (Dillman et al., 2009). Program registrants received two invitations, one week apart, to complete pre- and post-program surveys. We drew upon concepts from previous research to address construct validity (Shadish et al., 2002; Yin, 2003). We used IBM SPSS Statistics (version 24) software to determine whether there were any significant changes in these concepts by survey respondents based on pooled pre- and post-program responses. The Michigan State University Institutional Review Board approved the research IRB# x16–1350e (Category: Exempt 2,3) on October 20, 2016. Some statements, such as those in Table 3, measure more than one aspect; this results in double-barreled questions, which have validity concerns. We established the validity and reliability of our survey through the dual role of co-authors in the program, delivery, and evaluation design; however, more robust approaches for addressing validity and reliability exist (e.g., expert validation panel). Future evaluation would benefit from addressing these limitations.

RESULTS

Sixty-one percent (n = 59) of registrants completed the pre-survey, and 28% (n=27) completed the post-survey (Table 2). The following four statements about criticalness of content to respondents' work in water resource management exhibited significance at $p < 0.05$ (Table 3):

- understanding the hydrological cycle and its physical processes;
- Having knowledge of real-world examples relating to hydrological issues;
- being able to identify major pollutants and other factors that impact how fishable, swimmable, and drinkable water is;
- understanding the ways in which Michigan's residents make use of the state's freshwater resources.

Two statements exhibited significance at $p < 0.10$ (Table 3):

- being familiar with terms and definitions commonly used regarding hydrology and
- being familiar with where drinking water comes from.

Respondents rated all items as critical—except understanding the hydrological cycle and its physical processes—in the pre-survey. The difference between post- and pre-program data suggest a positive change in perceptions of criticalness to water resources management for all statements except two:

- Understanding the ways in which water figures prominently into local and regional economies; and
- evaluating the fiscal benefits that water conservation and regulation bring to economic sectors in the community (Table 3).

Respondents had a high level of water management knowledge prior to completing Water School, so we detected minimal gain in knowledge through the multiple choice and true/false questions. An average of 76.25% of pre-survey knowledge questions were correct and 81.37% of correct post-survey knowledge questions. About 19.33% of responses were incorrect on the pre-survey and 18.63% on the post survey. Respondents marked a total of 5.05% of responses *unsure* on the pre-survey, and none on the post-survey.

Respondents demonstrated significant post-program differences ($p < 0.06$) for three statements regarding attitudes toward water quality and management: (a) the quality of life in my community depends on good water quality; (b) my actions have an impact on water quality; and (c) it is not okay to reduce water quality to promote economic development (Table 4). All other attitudinal statements showed positive change in post-program results, but they were not statistically significant.

Four statements regarding perceptions of stewardship and behavioral intentions had significant differences ($p < 0.05$) between post- and pre-program responses:

- I can influence the solution of a water quality issue by acting on my own;
- I can make decisions about hydrology issues;
- I am confident that I can make a sound decision regarding hydrology issues; and
- I plan to protect wetlands in my municipality (Table 5).

Despite non-significance, all other statements regarding perceptions of stewardship and behavioral intentions had meaningful positive changes post-program compared to pre-program.

DISCUSSION

The results presented in this manuscript suggest that the Water School program was successful in creating positive change in some areas important for achieving water literacy; however, there are still areas that need improvement. The results presented here demonstrate changes in understanding of the hydrological cycle and physical processes, terms and definitions, knowledge of real-world examples, major pollutants, and other factors that correspond to the curriculum units on water quality, water quantity, field experiences, and local issues. Our evaluation detected increases in respondents' perceptions of stewardship and behavioral intentions to influence solutions to water quality issues by acting alone, making decisions about hydrological issues, having confidence in making sound decisions about hydrological issues, and planning to protect wetlands in their municipality.

Areas for program improvement include the curriculum and alignment of the water economics, planning, and finance unit and the water policy unit, as outcome results were mixed. There was some significant gain in understanding of the ways in which Michigan's residents make use of the state's freshwater resources and familiarity with where drinking water comes from. However, there was evidence of negative change post-program in knowledge items related to understanding how water figures prominently into local and regional economies and evaluating the fiscal benefits that water conservation and regulation bring to economic sectors in the community. This discrepancy may reveal the complexity of these issues, including a need for additional research-based information, perceived relevancy to local leaders, or presentation in the curriculum.

We recommend expanding the focus of Water School from building knowledge and appreciation to informing

Table 3. Respondents' Self-Assessment of Water Resource Management Criticalness to Work as a Municipal Official, Michigan Water School Program 2017–2019

Water resource management statement	Pre-survey		Post-survey		Difference between post and pre		
	Mean[1]	SD	Mean[1]	SD	ΔMean[1]	Z	p[2]
Understanding the hydrologic cycle and its physical processes.	3.92	0.73	4.37	0.57	0.45	-2.134	0.033
Being familiar with terms and definitions commonly used in regards to hydrology.	4.03	0.64	4.41	0.57	0.38	-1.806	0.071
Having knowledge of real-world examples relating to hydrological issues.	4.27	0.64	4.59	0.50	0.32	-2.138	0.033
The ability to identify major pollutants and other factors that impact the ability of water to be fishable, swimmable and drinkable.	4.57	0.65	4.81	0.40	0.24	-2.324	0.020
Having multiple solutions to help solve key water quality issues.	4.47	0.63	4.81	0.40	0.12	-1.171	0.242
Understanding the ways in which Michigan's residents make use of the state's freshwater resources.	4.14	0.81	4.44	0.70	0.30	-2.694	0.007
Being familiar with where drinking water comes from.	4.53	0.75	4.74	0.63	0.12	-1.696	0.090
Understanding the ways in which water figures prominently into local and regional economies.	4.29	0.73	4.26	0.81	-0.03	-0.442	0.659
Accessing strategies and resources to incorporate water into local planning and placemaking efforts.	4.37	0.69	4.44	0.70	0.07	-0.442	0.659
Evaluating the fiscal benefits that water conservation and regulation bring to economic sectors in the community.	4.31	0.70	4.15	0.82	-0.16	-0.667	0.505
Applying a risk management approach in water-related discussions and decisions.	4.14	0.80	4.33	0.73	0.19	-0.050	0.961
Being familiar with federal, tribal, state and local roles and responsibilities in water policy.	4.39	0.67	4.41	0.70	0.02	-0.790	0.430
Applying a framework for investigating a water policy issue.	4.10	0.80	4.35	0.69	0.25	-0.881	0.378
Exploring resources available to help address water quality problems.	4.34	0.71	4.67	0.48	0.33	-0.943	0.346

Note. Mean responses are on a 5-point scale where 1 = not critical at all, 2 = not very critical, 3 = neutral, 4 = critical, and 5 = very critical. Statistical significance between pre- and post- survey determined using Wilcoxon signed-ranks test.

decision-making, policy, network building, and leadership. Specifically, we could incorporate skills in leadership, communication, collaboration, and technology (Wolfson et al., 2015) into the program goals and curriculum to complement the water science, policy, and planning already included. These problem-solving and social learning approaches are also effective adult learning techniques (Knowles, 1968). A recent publication indicated that "unprecedented water management challenges [will] require new leaders with skills in the social sciences, in addition to technical skills; and new or modified leadership development programs are needed to master these skills" (Burbach & Reimers-Hild, 2019, p. 15). Specifically, effective water resources leadership will require skills of transformational leadership, championing innovations, civic capacity, and entrepreneurial leadership (Burbach & Reimers-Hild, 2019).

We believe there is room to expand marketing assessment and recruitment for program participation. However, we recognize that recruiting people who do not know what they do not know to participate in nonformal learning pro-

Table 4. Respondents' Self-Assessment of Attitudes Toward Water Quality and Management, Michigan Water School Program, 2017–2019

Water quality and management statement	Pre-survey		Post-survey		Difference between post and pre		
	Mean[1]	SD	Mean[1]	SD	Mean[1]	Z	p[2]
I would be willing to pay more to improve water quality.	4.07	0.77	4.19	0.54	0.12	-1.165	0.244
It is important to protect water quality even if it slows economic development.	4.23	0.70	4.50	0.56	0.27	-1.226	0.220
The quality of life in my community depends on good water quality.	4.40	0.79	4.81	0.16	0.41	-1.886	0.059
My actions have an impact on water quality.	4.37	0.81	4.77	0.18	0.40	-2.555	0.011
It is not okay to reduce water quality to promote economic development.	4.28	0.95	4.65	0.38	0.37	-2.097	0.036
The economic stability of my community depends on water quality.	4.19	0.94	4.31	0.52	0.12	-0.216	0.829
I would like to implement low-impact development plans in my community.	4.19	0.85	4.54	0.52	0.35	-1.361	0.173

Note. Mean responses are on a 5-point Likert-type with response options from 1 (strongly disagree) to 5 (strongly agree). Statistical significance between pre- and post-program surveys were determined using Wilcoxon signed-ranks test.

Table 5. Respondent Self-Assessment of Perceptions of Stewardship and Behavioral Intentions, Michigan Water School Program, 2017–2019

Behavior statement	Pre-survey		Post-survey		Difference between post and pre		
	Mean	SD	Mean	SD	Mean	Z	p[2]
I can influence the solution of a water quality issue by acting on my own.	3.23	1.13	3.46	1.12	0.23	-2.635	0.008
I can influence the solution of a water quality issue by acting with others.	4.44	0.56	4.69	0.54	0.25	-1.500	0.134
I can make decisions about hydrology issues.	3.46	0.92	3.80	0.75	0.34	-2.209	0.027
I am confident that I can make a sound decision regarding hydrology issues.	3.28	1.00	3.96	0.59	0.68	-3.335	0.001
I plan to share information about this workshop with others.	4.42	0.70	4.65	0.48	0.23	-1.000	0.317
I plan to implement low-impact development in my municipality.	3.70	0.82	3.92	0.87	0.22	-0.776	0.438
I plan to work to close and seal wells no longer in use in my municipality.	3.47	0.90	3.77	1.09	0.30	-0.561	0.575
I plan to protect wetlands in my municipality.	4.09	0.83	4.46	0.69	0.37	-2.012	0.044
I plan to work on issues related to wastewater treatment in my municipality.	3.77	0.84	4.00	0.88	0.23	-1.594	0.111
I plan to work on drinking water (source water) protection in my municipality.	4.21	0.75	4.27	0.76	0.06	-0.263	0.793
I plan to work on point-of-sale policies for well and septic inspections at time of home sale.	3.63	1.01	3.73	1.02	0.10	-0.221	0.825

Note. Mean response options are on a 5-point Likert-type scale from 1 (strongly disagree) to 5 (strongly agree). Statistical significance between pre- and post- survey responses was determined using Wilcoxon signed-ranks test.

grams is often a challenge for educational programming. Adult learning theories, also known as andragogy (Knowles, 1968), can be beneficial. Andragogical best practices recommend helping learners identify how they can use the information, facilitating participants' social learning in problem solving, and connecting to past experiences (Knowles, 1968).

Finally, Water School as presented and evaluated in this manuscript was a traditional two-day in-person program. As a result of the COVID-19 global pandemic, coordinators offered a modified virtual program using a variety of approaches (e.g., synchronous and asynchronous) in 2021 (Wolfson et al., 2015; Moreno-Guerrero et al., 2020). Further program planning will require evaluation of Water School instruction methods. The results herein reveal a need for improvement of program curriculum in two areas, refining how the curriculum addresses adult learning needs and fostering networks or cohorts of learners who are also local leaders. Although our evaluation design was to census all participants, our pre-program response rate (61%) was higher than the 2010–2017 average of 43% for natural resources surveys; the post-program response rate (28%) was lower (Stedman et al., 2019). Declining response rates in survey research are an ongoing challenge (Stedman et al., 2019; Connelly et al., 2003). In the future, we recommend a shorter survey for ongoing monitoring of program outcomes and suggest in-person distribution rather than online.

CONCLUSION

The Michigan Water School was an effective Extension education program for improving local leaders' knowledge, perceptions of criticalness to their work, and stewardship and behavioral intentions related to water quantity, quality, field experiences, and local issues. The program will require additional improvements in curriculum and instruction for water policy, planning, economics, and finance to further increase effectiveness. Local leaders have an important role in water resource management and achieving goals in Michigan's 30-year Water Strategy. Extension programs for this audience can build capacity and promote partnerships around water resources governance. It is necessary to combine this knowledge with effective leadership to address the complexity of responsibly managing freshwater resources.

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